A STATISTICAL SURVEY OF X-RAY EXPOSURE LEVELS FROM COMPUTER MONITOR SCREENS USED WITHIN THE FEDERAL UNIVERSITY OF TECHNOLOGY, BOSSO CAMPUS MINNA

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ABSTRACT
This work investigates the radiation levels of different computer monitor models used in Bosso Campus of the Federal University of Technology (FUT), Minna. A preliminary survey suggested that seven monitor models/brand accounts for more than 80% of the ones used within the campus. These models (Mercury-15″; HP-17″; Samsung-15″; Dell-15″; Compaq-15″; Maxtron-14″ and Manna-15″) were separately investigated for soft x-rays dose level. To measure the radiation dose from the screen a low radiation monitor (Digilert Nuclear Radiation Monitor, S.E. International, Inc., USA) designed to measure low level radiation and calibrated with a Cesium-137 gamma source was used. The monitor was position at 5cm from the Computer Screen. The mean total radiation count for 3600 seconds was used to evaluate the dose rate (mR/hr). The dose rate obtained for all the monitors ranges from 0.013mR/hr and 0.034mR/hr. The range of the dose rate obtained for all the monitors in this work is less than the 0.5mR/hr limit recommended by Food and Drug Administration Regulations in U.S.
Keywords: radiation, dose rate, computer monitor, x-rays.

1.0 INTRODUCTION

Radiation ranks among the most thoroughly investigated agents associated with disease [1]. The damage caused by the irradiation of human tissue derives from atomic and molecular interaction such as ionization, excitation and dissociation, which may eventually lead to clinical symptoms. The resulting biological effects of exposure of man to radiation are well known from experiments; observations on occupation exposure of workers (including: scientist, medical personnel, miners, atomic energy worker, industrial radiographers), patients exposed to radiation for diagnosis and therapy, people exposed to fallout of nuclear weapons debris accidents such as the wind scale accident in England in 1956 and Chernobyl disaster of 1986, Hiroshima and Nagasaki of 1945. Ionizing radiation injury is dependent on a number of factors including: The nature (α,β,γ) and energy of the radiation, the dose, time of exposure, homogeneity of dose and age of the individual exposed. It is known fact that neonates and children are more susceptible to harmful effects of ionizing radiation than adults at the same dose level [2]. This is so because of their greater cell proliferation rate and long life span expectancy, which also increases the probability of late (delayed) effects of radiation. When the dose and dose rate are within the accepted level, the effect of radiation is small and most of the time no effect is noticed, although the effect of low level radiation are not yet completely understood [3]. Humans are exposed to the radiation from diverse sources which could either be natural or artificial both are of equal risk to man. It has been reported that a potential source of radiation to computer users is the computer monitor [4].

Display devices have been in use almost as long as computers themselves. The Computer monitor or display unit is the most-used output device on a computer. The monitor provides instant feedback by showing text and graphic images as one work or play with the computer system. Many computer monitors available to us today employs the similar cathode-ray tubes (CRTs) used in television and radar systems.

The fundamental principle behind CRT displays is the emission of a controlled stream of electrons that strike light-emitting phosphors coating the inside of the screen. The sudden deceleration of fast moving electrons in this manner subsequently causes production of x-rays [5]. When an electron beam moving with energy that is dependent on the accelerating potential difference of the CRT strikes the phosphor-coated screen, some of the energy is dissipated as heat and some transferred to the electrons of the phosphor atoms making them to move to higher quantum energy levels. While returning to their ground level state, they give up their excited energy in the form of photons at frequencies predicted by quantum theory. Furthermore, the suddenly decelerated incident beam of electrons on impart with a target material like monitor screen, loses some of its kinetic energy as electromagnetic energy which is propagated as photons (x-rays). The energy spectrum of these x-rays is also determined by the accelerating voltage of the fast moving electrons.

Because of their slimmer design, smaller energy consumption, and low radiation production, monitors using LCD technologies are beginning to replace the current CRT on many desktops. Unfortunately monitors employing the CRT technology are still the commonest amongst many computer users in Nigeria today.

The danger inherent in the exposure to soft x-rays from display device (monitor) of computers has been a major concern for many computer users over the world. Inconclusive study [6] has made one wonder whether there are health hazard associated with the use of computer systems. According to Steedman and Hodgkinson in 1990 [7], there is a positive correlation between computer users and some radiation related illnesses. The outcome of this study has given a second thought to the manufacture of Computer systems in production of low-level radiation devices. The result of this study has thus become a critical factor in the manufacture of Computer systems and has informed the rating of Computers with the low-level of radiation mark. To this end the Food and Drug Administration in the U.S.A [8] has set limit for radiation dose rate from computer screen to 0.5mR/hr. In the light of the enormous risk associated with radiation exposure, it is thus necessary to evaluate the radiation risk associated with the use of computer monitor by evaluating the dose rate of radiation from computers used for different purposes and compare it with this standard.

The aim of this study is to identify the commonest brands of monitors used by various computer users within Bosso Campus of FUT Minna, determine the radiation exposure from the common Computer Monitors and also to ascertain which brand if any gives exposure rate greater than the 0.5mR/hr (at 5cm from the screen) recommended limit by the Food and Drug Administration in the U.S [8].

2.0 MATERIALS AND METHOD

A preliminary survey was conducted to ascertain the commonest Computer model used within the Bosso Campus of the Federal University of Technology Minna. An office-to-office visitation was conducted during the survey and a list of Computer models found in the offices was recorded. Because of time and accessibility difficulty, a random selection of the offices was done to cover the entire University Campus.

The selected and visited offices represent about 85% of the entire offices with working computer on the Campus. After the survey, seven computer models which represented more than 90% of the type of computer used on the campus with CRT monitors were selected. The seven selected computers were examined technically to ensure they are in healthy working condition.

Consequently, Radiation levels from the seven (7) different models and sizes of Computer Monitor Screen were measured with a dosimeter. The dosimeter was a Geiger Mueller tube based radiation monitor (dosimeter) (Digilert Nuclear Radiation Monitor; S.E. International, Inc, USA). The dosimeter is exclusively designed to serve as a low level radiation detector survey meter. It was calibrated with a Cesium – 137 gamma source. This instrument is capable of measuring gamma dose rates in the range 0 – 20mR/hr. These features make this dosimeter an ideal choice for the measurement of low level x-radiation from monitor screen. The dosimeter was positioned at 5cm [8] from the centre of the screen about 20 minute after it was booted. The total radiation activity (count) for 3600s was measured. The procedure was repeated twelve times and the average was deduced after deducting the total background count from each measured value.

3.0 RESULT AND DISCUSSION

The average total count obtained for each monitor was converted to dose rate using appropriate formula and the result is presented in table 1. Among the seven computers considered in this work one has screen size 17in. and another is 14 in. while the remaining five are 15 inch in size. Out of the seven monitors, HP presented the highest dose rate of 0.034 mR/hr and Compac 15" has the lowest dose rate of 0.013 mR/hr. Figure 1 shows the variation of dose rate between the monitors.

The variation in dose rate from the monitors could be explained using four factors- accelerating voltage, target material, technical factor and screen size.

X-rays from monitor could be bremmstrahlung and or fluorescence (characteristic) x-rays. Generally when a fast moving electron interacts with a material medium (target material), as in the case CRT, the electron could decelerate gradually or suddenly. A gradual deceleration yields bremmstrahlung x-rays while a sudden deceleration leads to an excited atom which on returning

to ground state gives off characteristic x-rays. The energy of the x-rays is dependent on the nature of the target material (phosphor screen).
The fraction of incident electron energy available for bremmstrahlung production is governed by the equation [1]:

$$f = 10^{-3} ZE \quad (1)$$

Where Z is the atomic number of the phosphor screen (target material) and E is the electron energy given as:

$$E = eV_o \quad (2)$$

where e is electronic charge and and V_o is the accelerating voltage of the electron (tube operating voltage) [9]. Thus the higher the value of Z, the higher the amount of x-rays produced.
Also, bigger screen size (tube size) implies higher operating voltage and consequently increase in x-ray production (equation 1).
A malfunction of any of the power electronic component could alter the operating voltage of the tube. This, itself will affect the amount of x-rays produced in it.
If all these factors are the same for all the monitors, one expect radiation dose rate to be the same for all the monitors. The variation of all or part of these factors could be responsible for the observed variation in dose rate of all monitors investigated.

Table 1: Radiation Dose Rate ± Standard Deviation from different Computer Monitors

Computer Monitor Manufacturer	Sizes (INCH)	Mean Dose Rate ± S.D (mR/hr)
MERCURY	15"	0.018 ± 0.004
HP	17"	0.034 ± 0.008
SAMSUNG	15"	0.018 ± 0.005
DELL	15"	0.015 ± 0.005
COMPAQ	15"	0.013 ± 0.005
MAXTRON	14"	0.029 ± 0.004
MANNA	15"	0.018 ± 0.006

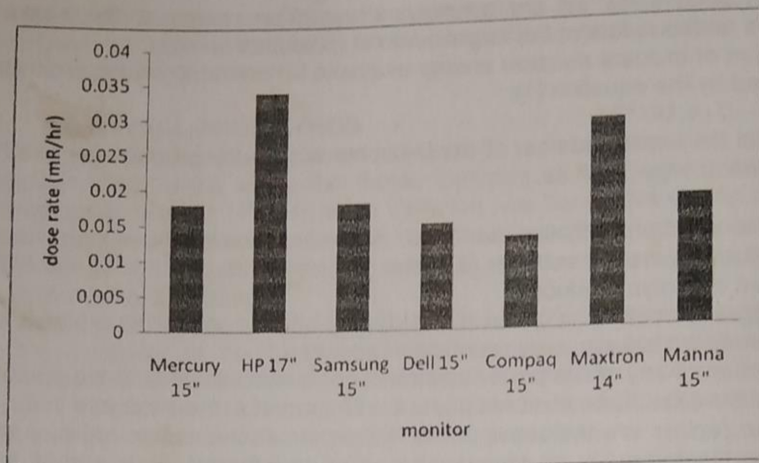

Fig.1. variation of dose rate for different monitors

4.0 CONCLUSION AND RECOMMENDATION

This work has confirmed the presence of radiation from Monitor screen of Computers used in Bosso Campus of Federal University of Technology Minna. Generally, the x-ray dose rate is in the range 0.013 (mR/hr) and 0.034 (mR/hr). The measured dose rate for the investigated monitors are low and within the recommended safe limit for x-rays exposure from computer screen at 5cm from centre of screen recommended by the U.S FDA (FDA, 2006).

Though this work confirmed that radiation emanating from Computer (CRT) screen model used in FUT Bosso Campus are low when compared to the 0.5mR/hr dose rate recommended by "Food and Drug Administration Regulations U.S" [8], it is worthy of note that the effect of low level ionizing radiation is not completely understood [3] and could range from immediate to delayed / latent effects like cancers which spans over several years before occurrence.

Hence, it is advice that where possible other screen model types like Touch Screen, Plasma Screen, and LCD which are free from ionizing radiation be used. The confirmation of the presence of radiation from CRT screen further add to the array of shortcomings of CRT monitor which includes the sizes and the enormous energies (25 kV) it consumes.

It is advised that the three (3) fundamental principle (time, distance and shielding) of external radiation protection be adhered to when using a Computer monitor.

The time spent using the Computer Screen where possible should be minimized, rather than taking a long period of time working with the system, it advised that one should take some minute break to allow the cells recover from any temporary damage that might have occurred. The longer one stays near a radiation source the higher the dose.

Also, the Computer users should maintain maximum distance possible from the monitor, because an inverse square exist between radiation dose and distance as in equation 3 [10]:

$$R = \frac{k}{d^2} \quad (3)$$

where R = Dose rate

d = Distance from the source

k = A constant value for a particular radioactive source.

Finally, where possible a thick transparent material (called Screen guide) or glass affix on the screen of the Monitor should be used, that would reduce the penetration or reduce the x-rays emanating from the monitor. Also, some of the antiglare panels that fit the Monitor screen not only reduce eyestrain, but also cut x-ray emission, by reducing the penetration [10].

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